

IN THE U.S. PATENT AND TRADEMARK OFFICE

Applicant(s): Klaus BEHRINGER
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For: DEVICE AND METHOD FOR PARAMETRIZABLE
CONTROLLING

LETTER

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Sir:

Amended claims are attached hereto (which correspond to Article 34 amendments or to claims attached to the International Preliminary Examination Report), as required by 35 U.S.C. § 371(c)(3). The Article 34 amended claims are incorporated in the included substitute specification and Preliminary Amendment.

Respectfully submitted,

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A controller of this high complexity is known, for example, from Pilz under the reference "PNOZ MULTI". A large part of the logic is in this case embodied in hardware. This is correspondingly configured extensively owing to redundancy and diversity, associated with an SFF level of more than 90% for the KAT4 safety standard. Two different controller types are in this case used with different firmware. The purpose of this is that the faster controller carries out the control functions and the slower controller is used for the monitoring.

US 4,510,602 discloses a programmable logic device which comprises a multiplicity of memory devices, instruction words and masking words being stored in each of these memory devices, the words respectively consisting of a multiplicity of bits. By means of a comparator unit and a comparer unit, a comparison of a word found on a data bus is carried out with an instruction word contained in a memory and a masking word. The data bus is in this case connected to inputs and outputs of the device. Depending on a comparison carried out, a marker unit which transfers a marker signal to outputs of the device is activated by the comparator unit. The individual bits of the instruction words and the masking words can take the digital states "1" and "0".

US 5,623,680 discloses a state machine, which comprises a memory in which logic specifications are stored. The changes of the outputs are determined by these logic specifications as a function of predetermined combinations of input parameters, and a change of states is carried out as a function of stored logic states of the input parameters. The state specifications are in this case formed by separate 8-bit

words and combined with an input vector by a logical AND operation. The input vectors are in this case undescribed and characterize that by that only a single state which is specified by a further vector can determine a state transition.

For their part, the present Applicant sells safety equipment of the Siguard series on the market, which makes do with one firmware and one controller type, although master-slave operation is necessary in which both controllers execute all the control functions and therefore in principle require double the runtime compared with the aforementioned equipment. This disadvantage must be compensated for by a high-performance algorithm.

It is therefore an object of the present invention to provide a less elaborate controller and a corresponding method for safety technology.

According to the invention, this object is achieved by a control device having a plurality of inputs for respectively receiving an input real value, a plurality of outputs for respectively outputting a digital output value, a memory for storing setpoint values relating to the inputs and outputs, and an allocator for allocating a digital output value to one of the digital outputs as a function of a comparison of at least one of the input real values with a corresponding setpoint value, wherein an independence state value can be applied to at least one of the setpoint values in the memory, and the allocation of a digital output value to one of the digital outputs can be carried out by the allocator independently of the at least one input real value whose allocated setpoint value has the independence state value. The setpoint values respectively have one of the state values 1, 0 and independence state value. In this way, for example, it is possible to produce the binary states "TRUE" and "FALSE" as well as a state

which is insignificant for the output result.

The invention also relates to a method for controlling equipment by receiving a plurality of input real values, providing setpoint values relating to input and outputs, establishing a digital output value as a function of a comparison of at least one of the input real values with a corresponding one of the setpoint values, outputting the digital output value, applying an independence state value to at least one of the setpoint values, and establishing the digital output value independently of the at least one input real value whose allocated setpoint value has the independence state value. The setpoint values respectively have one of the state values 1, 0 and independence state value. In this way, for example, it is possible to produce the binary states "TRUE" and "FALSE" as well as a state which is insignificant for the output result.

In safety technology, the error susceptibility and verifiability of the algorithm are of prime importance. If the computing outlay is reduced according to the invention, a reliable control function can therefore be readily achieved in master-slave operation.

The control device according to the invention may comprise a first evaluator for converting input raw values into digital input values for the further processing as input real values. This makes it possible, for example, to classify analog input signals as an active or inactive input.

A second evaluator may furthermore be provided in the control device, which is connected downstream of the first evaluator. This allows the digital input values to be allocated to logical input states for the further processing as input real values.

Preferably, the setpoint values respectively have one of the state values 1, 0 and independence state value. In this way, for example, it is possible to produce the binary states "TRUE" and "FALSE" as well as a state which is insignificant for the output result.

A plurality of sets of setpoint values are preferably stored respectively for an output value or set of output values in the memory. In this way, a plurality of parameterizations can be stored simultaneously in the equipment.

The control device according to the invention may have a safety instrument by which the equipment to be controlled can be switched to a safety state. For example, it may be switched to the safety state if the output real values deviate from the corresponding setpoint values for more than a predetermined time. In a special example of this, the control device may comprise two controllers which both execute the algorithm and store all fulfilled parameterizations as well as the output vector Y_j in binary form. These stored values are compared in each cycle. If they deviate for a time which is longer than a predetermined maximum time, then the equipment to be controlled is switched to a safe state.

The safety device may be optimized by checking the sets of setpoint values with a check sum at fixed time intervals. In particular, a setpoint value matrix i.e. a fixed parameterization, which is stored in the memory, may be secured by a cyclic CRC (cyclic redundancy check sum) and verified at fixed time intervals in order to discover errors in the matrix S or in the memory. In this way, a variable function can be checked for errors straightforwardly.

The present invention will now be explained in more detail with the aid of the appended drawings, in which:

New Patent Claims 1 to 13

1. A control device having

- a plurality of inputs for respectively receiving an input real value (F_i),
- a plurality of outputs for respectively outputting a digital output value (Y_j),
- a memory for storing setpoint values (S_i) relating to the inputs and outputs, and
- an allocator for allocating a digital output value (Y_j) to one of the digital outputs as a function of a comparison of at least one of the input real values (F_i) with a corresponding setpoint value,

characterized in that

- the setpoint values (S_i) respectively have one of the state values 1, 0 and independence state value,
- an independence state value (D) can be applied to at least one of the setpoint values (S_i) in the memory, and
- the allocation of a digital output value (Y_j) to one of the digital outputs can be carried out by the allocator independently of the at least one input real value (F_i) whose allocated setpoint value (S_i) has the independence state value (D).

2. The control device as claimed in claim 1, which comprises a first evaluator for converting input raw values (R_i) into digital input values (X_i) for the further processing as input real values.

3. The control device as claimed in claim 2, which comprises a second evaluator, connected downstream of the first, for allocating the digital input values (X_i) to logical input states (F_i) for the further processing as input real values.

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4. The control device as claimed in one of the preceding claims, wherein a plurality of sets of

setpoint values ($S_{i,n}$) can respectively be stored for an output value or set of output values in the memory.

5. The control device as claimed in one of the preceding claims, which has a safety instrument by which the equipment to be controlled can be switched to a safety state.

6. The control device as claimed in claim 5, wherein the safety instrument switches to the safety state if the input real values (F_i) deviate from the corresponding setpoint values ($S_{i,n}$) for more than a predetermined time.

7. The control device as claimed in claim 5 or 6, wherein the sets of setpoint values ($S_{i,n}$) are checked with a check sum at fixed time intervals.

8. A method for controlling equipment by

- receiving a plurality of input real values (F_i),
- providing setpoint values ($S_{i,n}$) relating to inputs and outputs,
- establishing a digital output value (Y_j) as a function of a comparison of at least one of the input real values (F_i) with a corresponding one of the setpoint values ($S_{i,n}$), and
- outputting the digital output value (Y_j),

characterized by

- application of an independence state value (D) to at least one of the setpoint values (S_i), and
- establishment of the digital output value (Y_j) independently of the at least one input real value (F_i) whose allocated setpoint value ($S_{i,n}$) has the independence state value (D),

wherein

- the setpoint values ($S_{i,n}$) respectively have one of the state values 1, 0 and independence state value (D).

9. The method as claimed in claim 8, wherein the reception of a plurality of input real values (F_i) comprises conversion (S1) of input raw values

(R_i) into digital input values (X_i) for the further processing as input real values (F_i).

10. The method as claimed in claim 9, wherein the digital input values (X_i) are allocated to logical input states for the further processing (S_2).

11. The method as claimed in one of claims 8 to 10, wherein a plurality of sets of setpoint values ($S_{i,n}$) are respectively provided for an output value (Y_j) or set of output values.

12. The method as claimed in one of claims 8 to 11, wherein the equipment to be controlled is switched to the safety state if the input real values (F_i) deviate from the corresponding setpoint values ($S_{i,n}$) for more than a predetermined time.

13. The method as claimed in one of claims 8 to 12, wherein the setpoint values ($S_{i,n}$) are checked with a check sum at fixed time intervals, and the equipment to be controlled is optionally switched to a safety state.